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The Retrieval of Mortalities from Salmon Farm Sea Cages

G I Sangster

Scottish Fisheries
Information Pamphlet
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CONTENTS

	Page
Introduction	1
Methods in Current Use for Retrieving Dead Fish	1
Principles of the Marine Laboratory Dead Sock System	3
Holster Construction	3
Holster Hoop Construction	4
Dead Sock Hoop Construction	5
Dead Sock Construction	5
Sock Rope and Pulley Rope	5
Fitting the System to a New Net: Installation and Operation	6
Fitting the Holster Hoop and Sock Rope	6
Fitting the Sock	6
Lowering the Sock	6
Raising the Sock— Checking for Dead Fish	9
Removing the Sock During Net Changes	9
Dead Sock Trials	11
Discussion	14
Video Programme	15
Possible Future Developments	15
Acknowledgements	15

The Retrieval of Mortalities from Salmon Farm Sea Cages

G I Sangster

Marine Laboratory
Aberdeen

Introduction

Considerable growth in the farming of Atlantic salmon (*Salmo salar* L.) in Scotland in the past decade has led to greater competition and the need for improved efficiency within the industry. One of the problems is that some salmon, which are kept in large netting compounds or sea cages, may die from disease. The dead fish are known in the industry as mortalities or "morts". A fish dead from a bacterial disease like furunculosis may remain undetected in a cage for a number of days, decompose and continue to release bacteria and spread infection. Furunculosis bacteria in just one infected fish may multiply at the rate of a hundred million every day.

This report reviews existing methods and describes a new, simplified, "mort" retrieval system, suitable for most common types of sea cage. It can be operated easily and quickly by one person, allowing frequent checking for and removal of dead salmon without undue stress on the healthy fish. The rapid recognition of a disease outbreak and diagnosis of the disease means that subsequent treatment can be effected without delay. Details are given of the construction of the new dead sock system and a description of its operation.

Methods in Current Use for Retrieving Dead Fish

Several different methods are in current use though none is entirely satisfactory. There is, for example, a system which uses a sock attached below the floor of the net to collect the dead fish (Fig. 1). This method requires two people and can be very strenuous. A mechanical winch to help lift fouled nets is sometimes necessary, adding expense and complexity. Furthermore, some "morts" in peripheral pockets may be missed and will rapidly spread infection as they decompose. The net floor of the cage is lifted to the surface when the sock is raised, greatly reducing available swimming space and causing stress to the captive fish. It is also possible for the net sock to be completely ripped out of the net during lifting, resulting in loss of the entire fish stock. The sock is usually lifted only once a week, by which time many dead fish may have decomposed and spread infection. Such "morts" are of no use for diagnostic samples and the task of retrieving such rotting carcasses is unpopular with farm staff.

A second method, "net lifting", involves starting at one end of the cage and progressively lifting opposite sides of the net in order to create a sloping floor, thereby accumulating the "morts" in a pocket at the far edge. This pocket is then carefully raised to the surface as the other end of the cage is gradually lowered to its original position. The dead fish in the pocket are then removed by brailers. Whilst this method should remove all dead and decaying fish it is unlikely to be undertaken more

than once a week owing to the manpower involved; at least three people are required to operate this system and it is stressful to both man and fish.

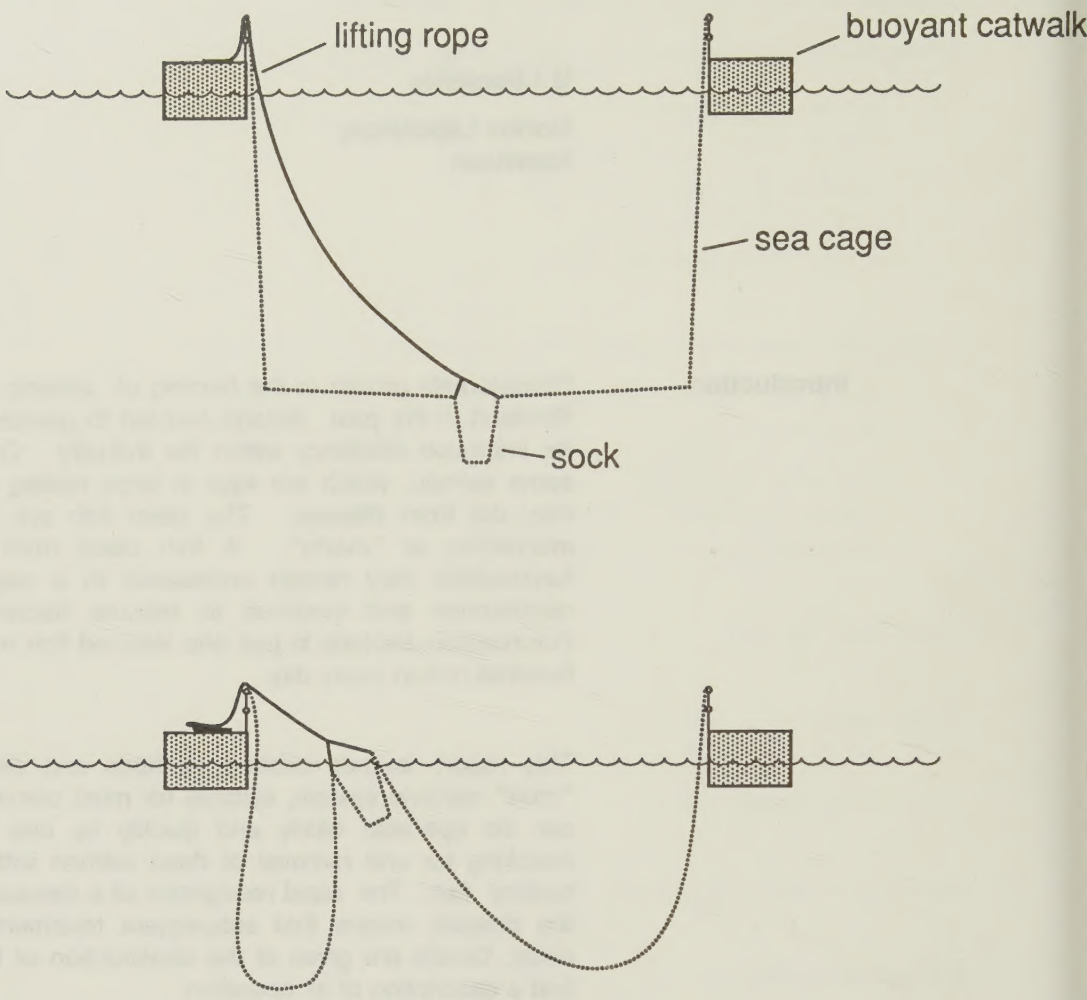

Figure 1. **The traditional dead sock method uses a cone shaped sock stitched into the floor of the sea cage. To remove the dead fish the sock is raised to the surface but this also raises the floor of the cage.**

SCUBA diving is a very efficient method of removing dead fish from sea cages. However, diving inside netting cages requires great care, stresses the fish, and is limited in duration and frequency owing to strict decompression schedules. Furthermore, employment of divers and back-up facilities is expensive.

A Norwegian "lift-up" system (Fig. 2) has been introduced to the UK industry. There are indications that it can only be successful if there is sufficient depth of water under the cage and that all the dead fish fall to the particular "sock-corner" of the net. Hauling the long tube-shaped sock to the surface from outside the cage can be heavy work and may require mechanical aid. Scottish farmers, unlike their Norwegian counterparts, generally do not have the required depth of water under their cages to allow operation of such a sock system.

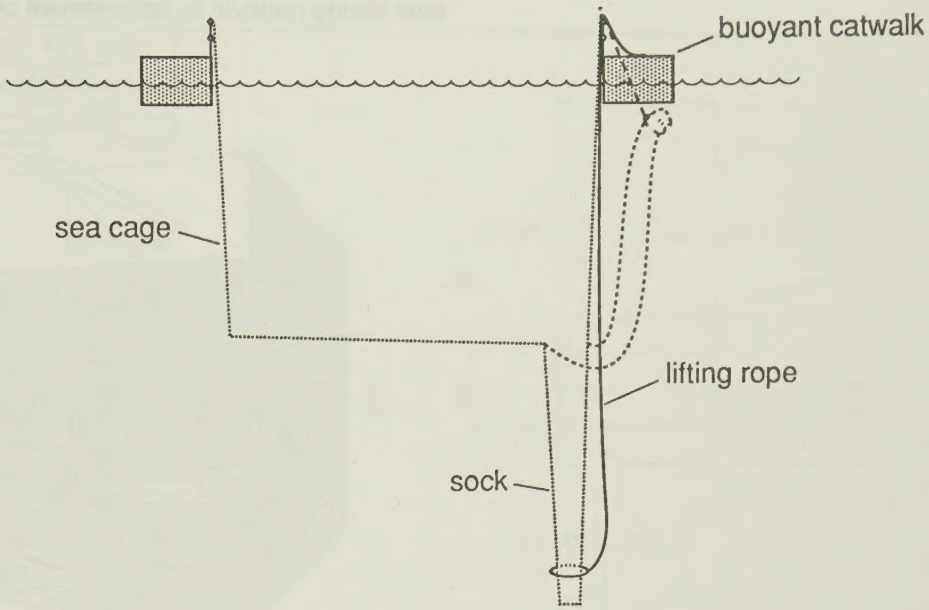

Figure 2. **The Norwegian "lift-up" technique requires a depth of water under the cage at least twice the depth of the cage itself.**

Clearly, each of the above methods has its limitations and there is a need for the new approach described below.

Principles of the Marine Laboratory Dead Sock System

The new system (Fig. 3) is very easy to operate. Dead fish are removed by a retractable sock which allows the operation to be done every day by one person. A cone-shaped holster is sewn into the exact centre of the floor on the underside of the net. The mouth of the cone is held open by a weighted hoop of alkathene pipe, which can be fitted and removed in seconds when the net has to be washed. The tip of the holster is fitted around a steel rope-guide which also acts as a counterweight, keeping the holster in the correct position below the floor of the cage. Another piece of cone-shaped netting, the sock, fits into the holster. The mouth of the sock is held open by a weighted hoop, attached to a rope bridle. A single rope leads from the bridle to the surface, over the handrail of the walkway, around the outside of the net and through the steel guide in the bottom of the holster. It is then attached to the base of the sock. This continuous loop is the means by which the sock is raised and lowered. During sock lifting, a knot part way along the sock rope loop acts as a stopper when it reaches the steel guide. Continued pulling on the rope from the surface results in the holster completely inverting so ensuring that no "morts" are in the holster cone prior to sock re-location. Conversely, on release of the top rope tension the holster's steel guide drops by gravity back through the floor of the cage, allowing the holster to again reform its true shape during sock re-location. A simple moveable pulley rope, stretched across the centre of the cage, between opposite walkway handrails, makes sure that the sock is always correctly located to drop vertically into the holster.

Holster Construction

Figure 4(a) shows the netting pattern necessary to construct the holster. Once the holster is made, a one metre diameter hole is cut in the exact centre of the base of the cage and the holster is laced around the cut edge. The holster cone should now hang down below the net. On the underside of the net, twelve 75 mm diameter plastic cod-end rings are then laced, equally spaced, around the join between the cage floor and holster. These rings will eventually accommodate the holster hoop during on-site installation. Figure 5 gives specifications for making the steel rope-guide. This guide is fitted just inside the apex of the holster cone and is secured with twine around its groove. No tails of netting or twine should

obstruct the bore of the guide; this will ensure free passage of the lifting rope during removal or replacement of the sock.

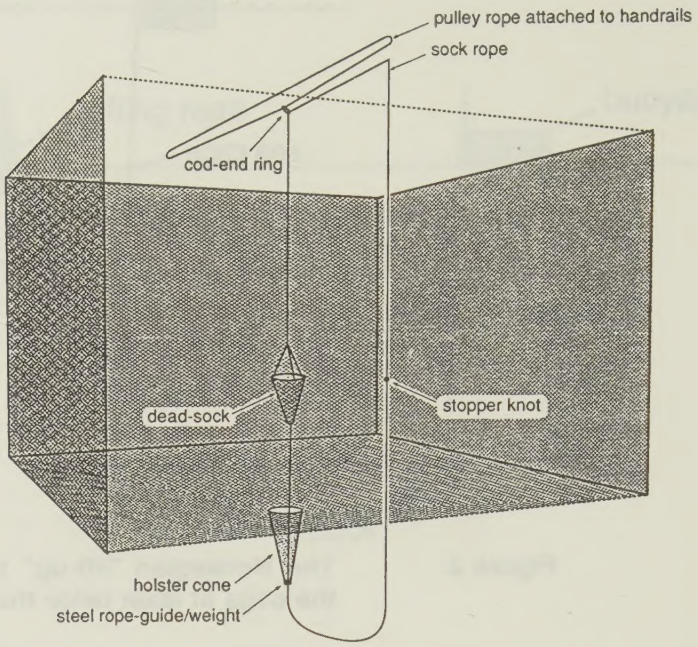

Figure 3. **A schematic diagram of the entire Marine Laboratory dead sock system in position in a rectangular sea cage.**

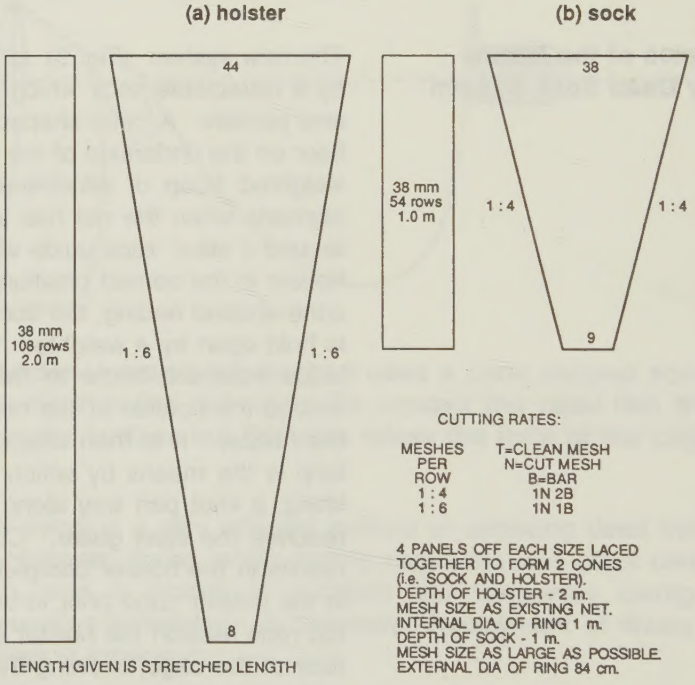

Figure 4. **The netting patterns required to construct (a) the holster and (b) the dead sock.**

Holster Hoop Construction

A length of 32 mm outside diameter blue alkathene waterpipe, with an internal bore of 25 mm, is used to construct a 1 m internal diameter hoop. Half of a 100 mm length of solid plastic rod of 25 mm outside diameter is secured into one end of the alkathene pipe. The pipe is made heavy, either with dry sand or a length of trawl wire. The other end of the pipe is bent round to accept the other half of the plastic rod. The 1 m holster hoop is then completed. A suitably sized hole is drilled through the pipe and rod, near the non-secured part of the join, to accept an electrical cable

tie which keeps the hoop intact during use, but enables it to be split apart periodically.

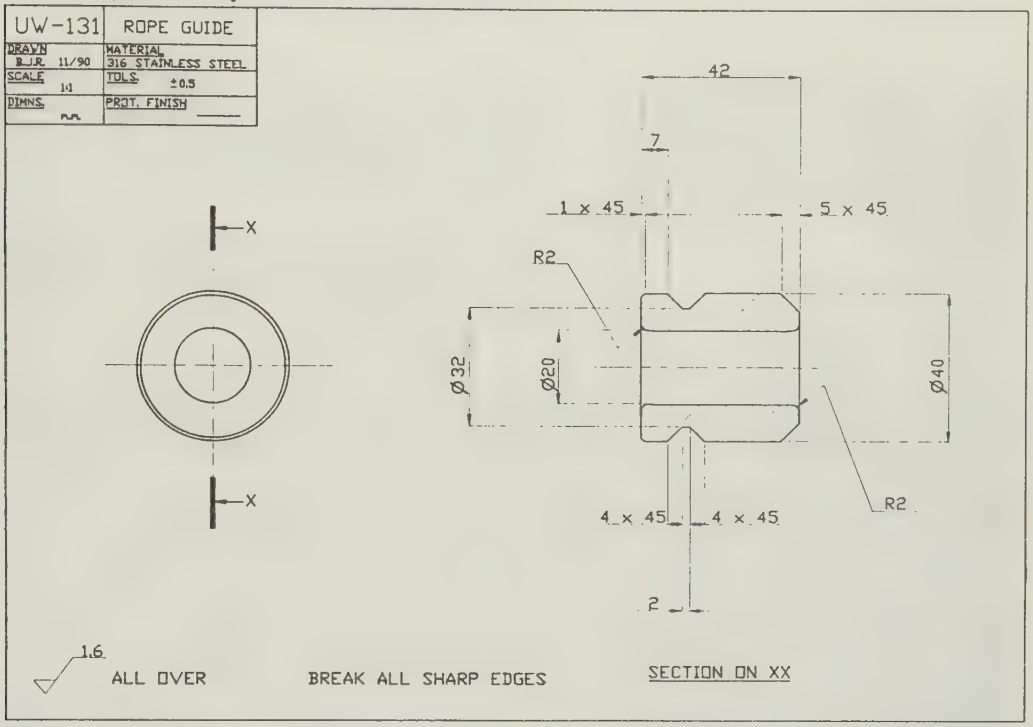

Figure 5. **Specification for making the stainless steel rope-guide.**

Dead Sock Hoop Construction

The hoop for the sock is made from the same materials as for the holster. The external diameter of this hoop is 0.85 m (0.9 m maximum). Anything larger than this will not allow the holster hoop to accept the sock hoop during re-location. The sock hoop is weighted in the same way as the holster hoop. Both ends of the alkathene pipe can be secured to the plastic rod during construction with self-tapping screws because this hoop does not require to be split periodically.

Dead Sock Construction

Figure 4(b) shows the netting pattern necessary to make the sock cone. Once constructed, the sock cone is securely laced around the periphery of the sock hoop with as few twine knot joins as possible to minimise snags during its insertion into, and retrieval from the holster. Three (70 cm x 8 mm diameter) nylon rope bridles are attached, equally spaced, around the hoop, with soft eyes at both ends. The three soft eyes at the loose ends will eventually be brought together to accept the upper end of the pulley rope during operation.

Sock Rope and Pulley Rope

An 8 mm diameter nylon rope is used for the sock rope, as it will sink to the floor of the sea cage when not in use and also run freely through the steel rope-guide, with a minimum of fraying. Other types of rope might float and possibly abrade the fish. The total length of this rope is calculated as follows:

length = (twice x depth of cage) plus (breadth OR twice x radius of cage) plus (twice x depth of holster) plus 3 m for slack.

The surface pulley rope need not be of the same material. The length of the pulley rope is twice the breadth (or diameter) of the cage. A suitable size of cod-end ring assists in the free running of the pulley system. For ease of identification, the two ends of the sock rope may be colour coded, eg one end black and the other white. A knot is tied half way along the

length of the sock rope that will neither pass nor partially jam in the bore of the steel guide. This knot must act as a stopper.

Fitting the System to a New Net: Installation and Operation

Fitting the Holster Hoop and Sock Rope

1. The net is laid on the ground and the length of plastic holster hoop passed through the 12 cod-end rings in the base of the net (Plate I). The ends of the pipe are fitted together (Plate II) and secured with the electrical cable tie.

2. From the underside of the net, the end of the sock rope (black code marked) is pushed through the steel rope-guide which is fitted to the bottom of the holster cone.

3. Enough rope is pulled through the holster to pass over the top of the net and the black end is then tied to the white end.

4. The net is folded in the usual manner for transport to its open sea site (Plate III), and is installed as part of a standard net change.

Fitting the Sock

5. The running rope pulley system is assembled across the breadth of the cage using the walkway handrails as anchor points.

6. Once the net is securely hung on the cage frame, the black and white marked ends of the sock rope are untied. The white end (ie the end on the outside of the net) is passed over the handrail, but inside the walkway, and through the rope pulley's cod-end ring.

7. The white end is tied to the lifting bridle of the sock (Plate IV).

8. The black end is tied to the bottom of the sock.

The system is now ready for operation.

Lowering the Sock (to be carried out at slack tide whenever possible)

9. The rope leading from the bottom of the sock is pulled until the holster is inverted. The inversion is caused by the stopping action of the knot in the lifting rope on the steel guide. This action ensures that the holster is empty prior to locating the sock (Plate V).

10. The pulley is pulled to the centre of the cage, allowing the sock to follow (Plate VI). The pulley rope is marked at the handrail to aid future centering.

11. The rope on the outside of the net is slowly pulled and at the same time the rope to the bridle is slowly payed out. These actions will allow the sock to drop vertically through the water and locate in the holster (Plate VII).

12. Once located, two to three metres of slack are allowed on the inside rope; this will prevent the sock being lifted out of the holster when the pulley is returned to the side of the rail.

Plate I. The ends of the plastic pipe passed through the cod-end rings on the underside of the net are fitted together to form the holster hoop.

Plate II. The mouth of the cone-shaped holster is held open by the weighted plastic pipe hoop.

Plate III. The net with its sock rope loop, holster and hoop assembly is folded in the usual manner for transport to its open sea site.

Plate IV. The rope is tied to the dead sock's bridle.

13. The pulley is pulled to the side and all the remaining slack rope passed down the inside of the cage. By marking the inside rope, just above the surface, the operator will always have the correct balance of rope between the inside and outside of the net.

Plate V. The holster in the inverted position which ensures that no fish are in the cone prior to sock re-location.

Raising the Sock — Checking for Dead Fish

14. Before lifting the sock, always give a couple of sharp tugs on the rope on the outside of the cage. This will agitate the cage floor and should be sufficient to dislodge any dead fish which may be lying on the netting just outside the sock, causing them to slip into the sock.

15. The pulley is pulled to the centre of the cage. The sock is raised to the surface (Plate VIII) by hauling on the inside rope, whilst at the same time, paying out on the outside rope. When the sock reaches the surface (Plate IX), the pulley and sock are pulled to the side rail (Plate X).

16. Any dead fish are removed.

17. Steps 9 to 13 are repeated, paying particular attention to step 9.

Removing the Sock During Net Changes

18. Steps 14 to 16 are repeated.

19. The rope is untied from the bridle and at the bottom of the sock, retaining the rope ends.

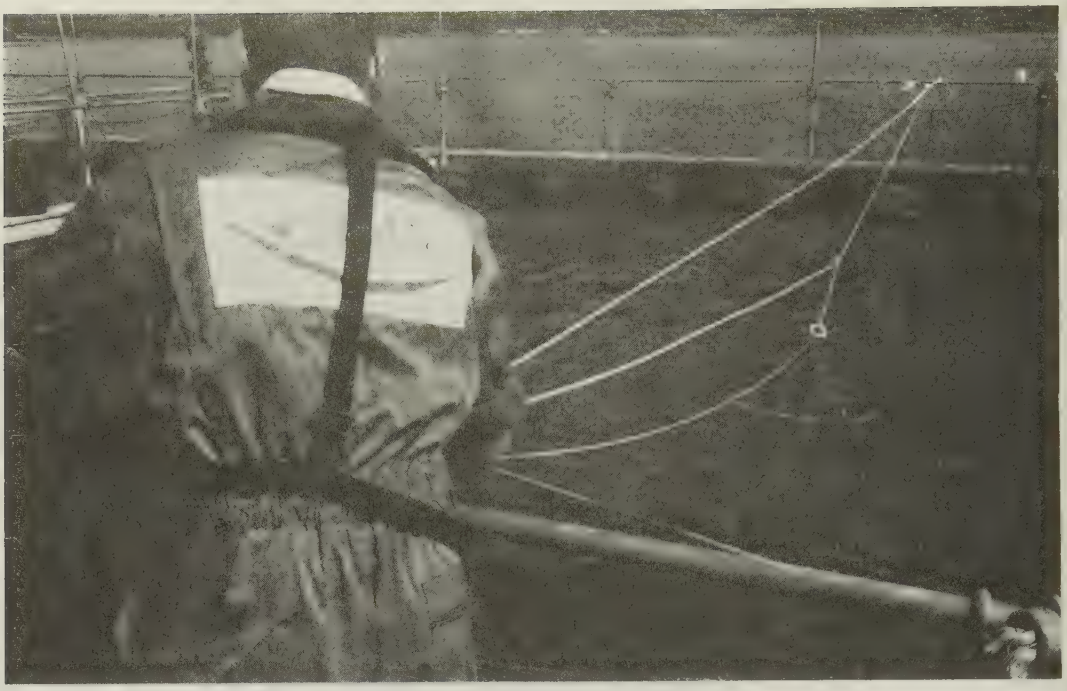

Plate VI. The pulley's plastic ring is hauled to the centre of the cage allowing the sock and the sock rope to follow.

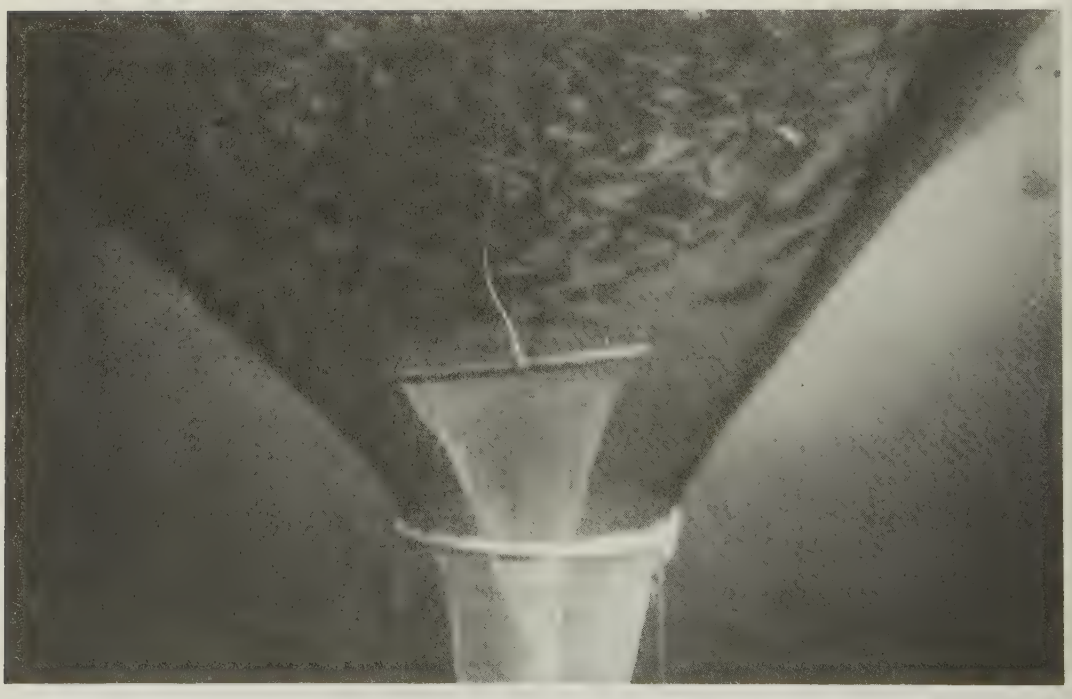

Plate VII. The sock has dropped vertically through the water and is about to locate in the holster.

20. The sock is removed but not the rope.

21. The two ends of the rope are tied together and the inside rope pulled to invert the holster. The rope is tied off to keep the holster inverted, as this will aid net changing. The net can then be changed.

22. When the new net is in place, the lifting rope is untied and removed completely from the net to be washed.

Plate VIII.The dead sock is raised to the surface by pulling on the inside rope.

23. The holster hoop is removed by cutting the electrical tie, so breaking the hoop at its join. The hoop can then be pulled free of the cod-end rings.

24. The steel guide should always be removed from the apex of the holster as its presence will cause damage to the net during washing.

25. The net is washed as normal. Return to step 1 for installation.

NB. Whenever possible the sock should be lifted at slack tide or at least when tides are at their weakest. This ensures that the sock is kept vertically in the water column. When the sock is being located, it is best to pull the outside rope slowly, allowing sufficient slack on the inside rope.

Dead Sock Trials

The dead sock system was tested at four Scottish salmon farms during the spring and summer of 1990. Conditions varied from site to site and between the different types of net. The four farms used dissimilar nets and the sites varied in size and environment.

Plate IX. Continued pulling on the inside rope and paying out the outside rope brings the dead sock to the surface.

Plate X. The dead sock and the pulley rope are hauled to the side of the cage and any fish removed.

McConnell Salmon at Oronsay Island, Loch Sunart, tested for 3 months the dead sock in a 12 m square sea cage containing about 5,000 2 kg fish. Occasionally, a television camera was lowered into the cage to monitor the effectiveness of the dead sock system. Staff found the system very labour saving, easy to use, with the whole "morting" procedure taking one man only 4 minutes to complete. It was found that for efficient functioning of the system, it was vital that the procedure outlined above was followed exactly. The sock held a maximum of twenty 2 kg fish and as soon as the number of "morts" increased dead fish lay around the periphery of the sock and occasionally one would slide into the holster when the sock was raised. To remove these fish, it was necessary to invert the holster normally and carry out a complete repetition of the dead sock procedure until no further dead fish were recovered from the sock. Following installation of the sock, mortalities were initially low with only 15 dead fish removed in the first three weeks. Television provided evidence of sock efficiency and it was concluded that the system was removing all the dead fish. Subsequently there was an increase in mortality indicating the start of a furunculosis outbreak. Daily fresh "mort" samples allowed quick diagnostic confirmation of the disease. With traditional weekly removal of dead fish, this outbreak was unlikely to have been detected until the following week. Over the next 3 weeks, there were many deaths from furunculosis and the dead sock procedure had to be operated more than once daily. However, once the infection was controlled, the system continued to operate effectively with low numbers being removed daily at a single lift. McConnell's found that daily use of the dead sock provided a much earlier indication of a disease outbreak while the decomposition of dead diseased fish was greatly reduced. The company commented that a larger system of the same design would be an advantage on farms where outbreaks of disease and large numbers of "morts" were a problem. Moreover, the Oronsay Island site does not experience strong currents; on other sites with more severe tides complete "mort" removal from large numbers of cages using dead socks only during slack water may be impractical.

Glendale Salmon Ltd carried out dead sock trials on a 12 m diameter "Polar Cirkel" sea cage at a remote and exposed site to the north west of Skye. As a small salmon farm with four circular type cages their "mort" removal had been carried out by local SCUBA divers. The Glendale staff found the dead sock method very effective and simple to use, allowing them to remove dead fish daily without the need and expense of divers. They experienced no problems and have continued to use the method daily.

In contrast, Marine Harvest's site at the upper end of Loch Sunart is very large. Here, the system was tested on a 16 m square cage containing between 5,000 and 6,000 mature salmon. At the time of the trials, an outbreak of a bacterial infection was affecting some of the multi-cage compounds. The dead sock system was regarded as a cheap and relatively simple modification to any existing net. The system could be rigged while the net was being checked, before commencing a net change and easily dismantled prior to net washing. Furthermore, once the cage (with the holster attached) was in position on site only the netting sock needed to be installed, an easy operation. Furthermore, no alteration to normal farming procedure was necessary when the fish in the dead sock cage were treated for sea lice infestation. The company also reported that the non-strenuous operation allowed quick and effective removal of dead fish from sea cages by one person with a minimum of instruction. No additional equipment, like winches, cranes or boats, was necessary. Marine Harvest was also very pleased with a 98% "morts" removal efficiency over the test period, and remarked that inverting the holster, after sock lifting, resulted in only a 0.1% reduction in net volume

compared with up to 47% with other methods. The system was therefore a lot less stressful to the fish. The only disadvantage foreseen was that the system had to be used ideally at slack tide, and that the very strong currents and tides at some of Marine Harvest's sites may pose a problem. Nevertheless, the system appeared to have many advantages for the industry.

At Fannagmore, in the far north-west of Scotland, Joseph Johnstone Ltd conducted trials with the dead sock system in an 8 m square sea cage. The site manager stated that the Marine Laboratory dead sock system was attractive to the commercial fish farmer by virtue of its simplicity and single person operation. Johnstone's have continued to use the system on a daily basis and recently arranged for 10 new 12 m sea cages to be manufactured, each fitted with the Marine Laboratory dead sock system.

Discussion

The results of trials by four independent commercial salmon companies using 8, 12 and 16 m square cages and a 12 m diameter circular cage confirm that the Marine Laboratory dead sock system is an important addition to the health control equipment available to the farmer. The method forms an important component in the package of husbandry techniques aimed at controlling disease, particularly furunculosis, and is a useful contribution to the drive to maintain and increase farming profitability.

The advantages of the Marine Laboratory type of dead fish removal system may be summarised as follows:

i) It can be fitted to existing nets, and requires only a cheap modification.

ii) It is very easy to use after a minimum of instruction.

iii) It is easy to rig prior to a net change.

iv) The net can be changed with the holster hoop and sock lifting rope in position.

v) It is easy to dismantle prior to net washing.

vi) The external holster hoop maintains a good net shape and does not prevent dead fish from entering the retractable sock.

vii) The holster can be easily inverted to ensure that no dead fish are trapped.

viii) Sea lice treatment can be carried out in the normal manner.

ix) The sock can be operated daily by one person without strenuous effort.

x) The whole lifting and lowering procedure takes approximately 4 minutes.

xi) It causes less stress to the fish than other methods.

xii) It is less strenuous than other methods, thereby reducing the risk of physical injury to staff.

xiii) It provides the farmer with an early indication of a disease outbreak on a daily basis.

xiv) It provides fresh samples of dead fish daily for post-mortem examination and disease monitoring.

Only two drawbacks to the current design have been identified:

i) The system is best operated at slack tide for ease of sock re-location.

ii) In its present form, the sock can cope with only about 20 dead adult fish during a single lift.

Video Programme

A 15 minute VHS format colour video programme entitled "Morts removal - an answer" has been prepared to describe the dead sock system. The programme was produced by the SOAFD Marine Laboratory, Aberdeen and the Scottish Salmon Growers Association Ltd. It contains a comprehensive step-by-step commentary on the everyday use of the system on site and is accompanied by a four page technical leaflet to assist with the construction and installation of a dead sock. The complete package is available from the Scottish Salmon Growers Association Ltd, Drummond House, Scott Street, Perth, PH1 5EJ, Scotland, UK.

Possible Future Developments

The dead sock system was not designed to cope with very high death rates in sea cages. The retrieval of large numbers of dead fish during a major furunculosis outbreak requires larger sizes of socks (and holsters). Care should be taken to ensure that any size change does not alter the simplicity of the system for the commercial user.

Acknowledgements

Special thanks are owed to a former colleague Dr Graeme Dear (now with McConnell Salmon Ltd) who worked closely with the author on the initial development of the dead sock system, and to Mr Bill Gray (Marine Laboratory Net Store technical foreman) for his specialised knowledge during the development work and installation of the nets during the site trials. The author is also most grateful to Dr A.D. Hawkins, Dr P.A.M. Stewart, Dr A.L.S. Munro and Mr R.S.T. Ferro for their suggestions and constructive criticism of the manuscript. Thanks also go to the salmon farm site managers and their staff who participated in the trials for their willing help, patience and enthusiasm during many aspects of the work.